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Larval stages of the deep-sea fishes in the channel area of the central Adriatic

Larvalni stadiji dubinskih vrsta riba u kanalskom području srednjeg Jadrana

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INTRODUCTION

The list of meso- and bathypelagic species of the Adriatic was made on the basis of the material collected mainly during the THOR (1908—1910), NAJADE (1911—1914) and HVAR (1948—1949) Expeditions. Their distribution was also worked out the basis of this material. The data on the adult and developmental stages of these fishes orginate from the papers of Steuer (1913), Jespersen (1915), Ege (1918), Tåning (1918), Jespersen and Tåning (1926) and Karlovac (1953). After the data of these authors the distributions of the planktonic eggs, larval stages and the adlut forms show the presence of meso and bathypelagic fishes above the greater depths of the southern and central Adriatic, mainly above the South Adriatic Pit and the Jabuka Pit.

This short communication aims to point to the occurrence of the larval stages of some meso and bathypelagic fishes, as well as of one benthopelagic species, characteristic for the depths between 140 and 600 m, in the relatively shallow area of the central Adriatic.

STUDY AREA, MATERIAL AND METHODS

The investigations were carried out at four stations along the profile at the level of Split (Fig. 1). The first station the *Kaštela Bay* is located in the relatively closed coastal area of the Kaštela Bay above the depth of 42 metres.

The stations *Split Strait* and *Pelegrin* are above the 80 metres and 75 meteres depth respectively. The former station is located in the Split Strait between the islands of Šolta and Brač and the latter close to the cape Pelegrin in the northwestern part of the Hvar Island. These stations are representative for the channel area of the central Adriatic. The fourth station, *Stončica,* is located 4 Nm southeasterly from the cape Stončica on the Vis Island, above the 107 metres depth. The Kaštela Bay Station is exposed to the strong land influence. Therefore the annual ranges of variations in temperature and salinity are high here, and the values of salinity considerably lower than those in the channel area and in the open waters of the central Adriatic. Annual ranges of temperature and salinity are gradually reduced as on proceedes off the coast towards the open sea (Buljan and Zore-Armanda, 1979).

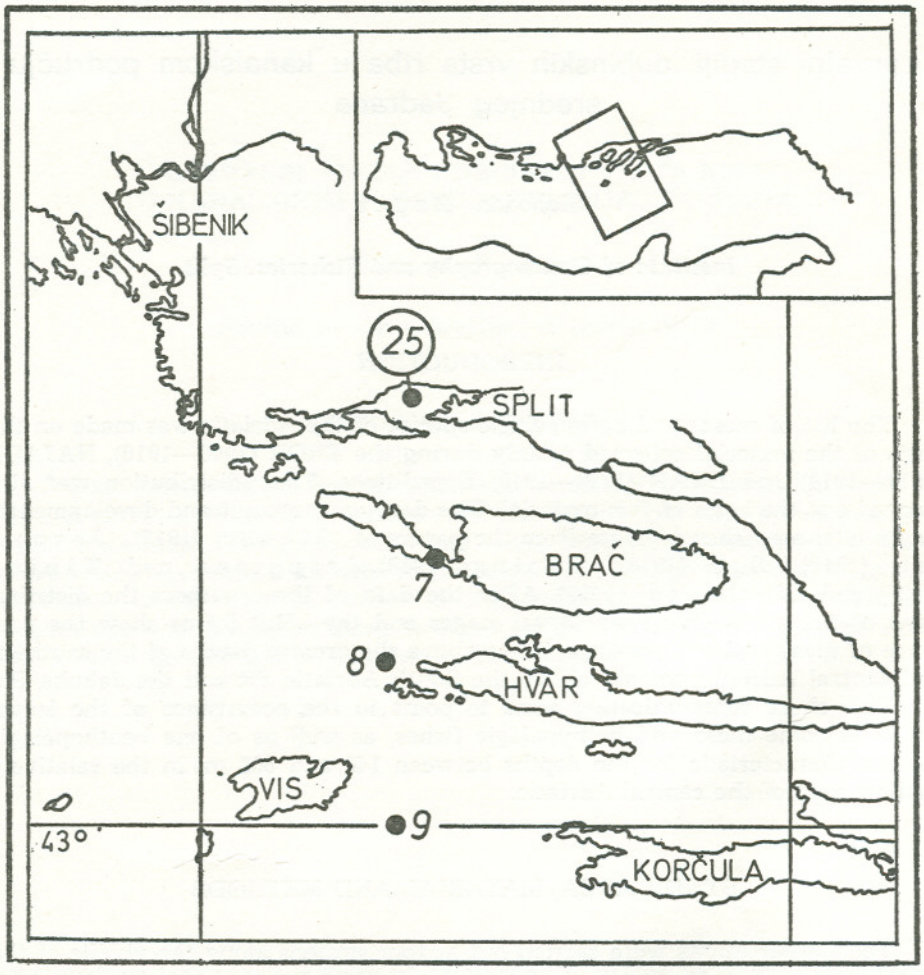

Fig. 1. Study area: 25 = Kaštela Bay, 7 = Split Strait, 8 = Pelegrin, 9 = Stončica

The material was collected on a monthly basis from January 1971 to Decembar 1976, by the double vertical hauls of the plankton net of »Helgoland« type. The area of net aperture is 1.6 m^2, and mesh size 0.516 mm. The net was towed at a speed of 0.5 m/sec from the depth of 75 metres to 0 metres at station Stončica, Pelegrin and Split Strait, and from 35 to 0 metres at the station Kaštela Bay. The planktonic material was preserved in the 2% solution of neutralized formol in the sea water. The planktonic stages of fishes were extracted from the rest of the planktonic material, identified and counted. The standard lenght (LS) was measured in larvae and postlarvae from the top of snout to the base of tail fin.

RESULTS AND DISCUSSION

The larval and postlarval stages of the following fish species characteristic for deep waters were recorded during the six years of investigations:

Familia	Species
Gonostomiatidae	*Gonostoma denudatum* Rafinesque, 1810
	Cyclothone braueri Jespersen & Tåning, 1926
	Maurolicus muelleri (Gmelin, 1789)
	Vinciguerria attenuata (Cocco, 1838)
	Vinciguerria poweriae (Cocco, 1838)
Stomiatidae	*Stomias boa boa* (Risso, 1810)
Myctophidae	*Electrona rissoi* (Cocco, 1892)
Macruridae	*Coelorhynchus coelorhynchus* (Risso, 1810)

All these species, except for the benthopelagic species *Coelorcynchus coelorhynchus*, are either meso or bathypelagic in their adlult stages. Out of the 25 meso and bathypelagic fishes of these families recorded from the Adriatic up to now (Karlovac, 1953) seven (28 %) were recorded from the studied profile.

Throughout the period of investigations 5 species and 22 specimens were recorded from Stončica Station, 6 species and 7 individuals from Pelegrin, and only one species and 3 individuals from the Split Strait (Table 1). The larval stages of these species have never been found in the closed coastal area at station Kaštela Bay. Further, as it may be seen from Table 1, the number of postlarvae exceedes the number of found larvae to a considerable extent. It is as evident that both the number of species and the number of individuals decrease if one proceeds from the areas affected by the open sea (Stončica Station) deeper to the channel area (Station Split Strait). This distribution is in close agreement with all that has been reported for these species up to now.

Namely, the species *Gonostoma denudatum* have been up to now recorded in the South Adriatic Pit above the depths of 200 m (Tåning, 1926; Karlovac, 1953). *Cyclothone braueri* was found in the area both of the South Adriatic Pit and Jabuka Pit (Tåning, 1926; Karlovac, 1953). The postlarval individuals were found in both of the pits, whereas the larval and the

Table 1. Place and Time of records of the larval stages of the deep-sea fish species at the studied profile (*the number of individuals is given per a double haul of plankton net, **damaged individual)

Station			Larvae		Postlarvae	
Date	Year	Species	Nr. ind*	LS (mm)	Nr. ind.*	LS (mm)
STONČICA						
02. 02.	1971.	*Vinciguerria attenuata*	—	—	1	7.57
08. 11.	1971.	*Gonostoma denudatum*	—	—	1	6.18
16. 02.	1972.	*Maurolicus muelleri*	—	—	1	4.50
16. 02.	1972.	*Electrona rissoi*	—	—	1	4.61
03. 11.	1972.	*Cyclothone braueri*	2	**	1	**
03. 11.	1972.	*Maurolicus muelleri*	—	—	1	3.93
10. 01.	1973.	*Cyclothone braueri*	—	—	1	3.26
10. 01.	1973.	*Maurolicus muelleri*	—	—	1	3.67
18. 12.	1973.	*Maurolicus muelleri*	—	—	3	4.31, 4.62, 6.00
18. 12.	1973.	*Electrona rissoi*	—	—	1	4.57
16. 01.	1974.	*Maurolicus muelleri*	—	—	1	3.83
13. 04.	1974.	*Maurolicus muelleri*	—	—	1	5.06
21. 09.	1974.	*Maurolicus muelleri*	3	2.63, 2.70, 2.81	2	3.56, 4.88
26. 12.	1975.	*Maurolicus muelleri*	—	—	1	3.45
PELEGRIN						
03. 02.	1971.	*Electrona rissoi*	—	—	1	4.31
28. 03.	1972.	*Cyclothone braueri*	—	—	1	4.01
10. 02.	1973.	*Cyclothone braurei*	—	—	1	3.07
23. 12.	1973.	*Coelorhynchus coelorhynchus*	1	3,56	—	—
23. 10.	1974.	*Cyclothone braueri*	—	—	1	5.10
13. 11.	1974.	*Stomias boa boa*	—	—	1	**
22. 10.	1975.	*Vinciguerria poweriae*	—	—	1	10.50
SPLIT STRAIT						
13. 01.	1973.	*Maurolicus muelleri*	—	—	1	4.70
23. 12.	1973.	*Maurolicus muelleri*	—	—	1	4.38
02. 02.	1975.	*Maurolicus muelleri*	—	—	1	7.69

adult ones were found only in the South Adriatic Pit (Karlovac, 1953). After Karlovac, the postlarvae of this species may be found in the surface layers only, whereas their other stages may be found only at greater depths. Postlarvae of *Maurolicus muelleri* were recorded from the rather large area, from the Island Dugi otok to Dubrovnik, whereas their larval and adlult stages were found only in the Jabuka Pit (Karlovac, 1953). *Vinciguerria attenuata* postlarvae were recorded above the Jabuka Pit and South Adriatic Pit, whereas their adults were found only above the South Adriatic Pit (Karlovac, 1953). *Vinciguerria poweriae* was recorded also in the Jabuka Pit and South Adriatic Pit. The postlarvae of this species were recorded only from the surface layers (Karlovac, 1953). *Stomias boa boa* postlarvae were also

found above the South Adriatic and Jabuka Pit. The postlarvae of this species were found in the surface layers and the metamorphosed and adlut individuals at greater depths (K a r l o v a c, 1953). Thus, it is the property of all these species that their postlarvae mainly inhabit the surface layers, whereas their larvae and adults live deeper. The spatial distribution of postlarvae is also wider than that of larvae and adults. This accounts for the records of the development stages of these fish species in the channel area, as well as the excess in number of postlarvae with respect to larvae.

The *Coelorhynchus coelorhynchus* eggs were found by S t e u e r (1913) in the surface layers of the Jabuka Pit. Larger quantities of adults of this species were found in the bottom layers of the South Adriatic Pit, between the depth countorus of 300 to 500 metres (M e r k e r and N i n č i ć, 1973). Only one adult individual was recorded from the Jabuka Pit (Š o l j a n, 1965).

The only data on records of the larval stages of deep-sea fish species in the channel area have been however, reported by K a r l o v a c (1967). After this author, the larval stages of the species *Diaphus rafinesquei* (Cocco, 1838) were found in the Split Channel together with the species *Cyclothone braueri.* Larval stages of the species *Maurolicus muelleri* were recorded from the Brač Channel.

On the basis of everything said above it may be assumed that the larvae and postlarvae of all the species found were carried to the channel area of the central Adriatic by currents. This is of importance since they may be good indicators of the flow of the surface water masses onshore. The comparison between the time when they were found at the investigated profile and the time of their occurrence in the open sea of the Adriatic and the Mediterranean may be well indicative of this phenomenon (Tables 2 and 3).

Table 2. The distribution of the number of larval stages of the deep-sea fishes along the studied profile given by months

	months							
Station	Sep	Oct	Nov	Dec	Jan	Feb	March	April
Stončica	5	0	5	5	3	3	0	1
Pelegrin	0	2	1	1	0	2	1	0
Splitska vrata	0	0	0	1	1	1	0	0

As it is evident from the Table 2, the period in which the larval stages of these fishes are recorded is longest at station Stončica (from Septembar to April). This station is under the direct influence of the open sea. This period covers only three month (December—February) at station Split Strait, which is closest to the coast. Acordingly, the larval stages of these fishes may be found deeper in the channel area only during winter months.

However, according to the data as given in Table 3, the period of occurrence of all the species recorded in the plankton, except for the species *Coelorhynchus coelorhynchus,* exceeds the period of their occurence it the studied profile to a considerable extent. Thus it is evident that their occurrence in the

Table 3. Time of occurrence of eggs, larvae and postlarvae of the observed deep-sea fish species of the Adriatic and Mediterranean (A = ADRIATIC; M = MEDITERRANEAN).

Species		1	2	3	4	5	6	7	8	9	10	11	12	Author
Gonstoma denudatum	A					x								Karlovac, 1953.
	M				winter and spring									Sanzo, 1933.
Cyclothone braueri	A				x	x	x				x	x		Karlovac, 1953.
	M				summer — winter									Sanzo, 1933.
Maurolicus muelleri	A		x	x	x	x	x	x			x			Karlovac, 1953.
	M				the whole year									Sanzo, 1933.
Vinciguerria attenuata	A			x	x	x	x			x	x			Karlovac, 1953.
	M				Novembar — May									Sanzo, 1933.
Vinciguerria poweriae	A			x	x	x	x				x			Karlovac, 1953.
	M				Novembar — May									Sanzo, 1933.
Stomias boa boa	A				x	x								Karlovac, 1953.
	M				the whole year									Ege, 1918.
Electrona rissoi	A					x	x							Karlovac, 1953.
	M		x	x	x									Tortonese, 1956.
Coelorhynchus coelorhynchus	A													
	M												x	Sanzo, 1933.

channel area coincides with the onshore resultant directions of surface currents. According to the long-term investigations into the currents of the central Adriatic (Zore-Armanda, 1968) the resultant directions of surface currents are NW in winter and N in spring, i. e. from the open sea onshore in the periods when the larval stages of deep-sea fishes were recorded from the studied profile.

CONCLUSIONS

1. Larvae and postlarvae of seven species of meso and bathypelagic fishes and of one benthopelagic species characteristic for greater depths (300—500 m) were found at the studied profile which includes the area of the central Adriatic affected by the open sea, the channel and closed areas, during six years of investigations. All these species were recorded from the stations of the profile affected by the open sea as well as from the channel area. However, they were never recorded from the closed coastal area.

2. Both the number of species and the number of individuals were found to decrease going from the open sea to the channel area. The time of their presence in the samples is also reduced in the onshore direction. Thus at the Split Strait station which is closest to the coast, only one species was found not longer than during three winter months, from December to February.

3. Since the period of reproduction of the largest number of these species extends the whole year through and they are recorded from the channel area only during the colder period of the year (October—March) it may be concluded that they may be taken as good indicators of the flow of the surface water masses in an onshore direction during the winter months and early spring.

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LARVALNI STADIJI DUBINSKIH VRSTA RIBA U KANALSKOM PODRUČJU SREDNJEG JADRANA

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KRATAK SADRŽAJ

Tokom šestogodišnjih ihtoplanktonskih istraživanja na području srednjeg Jadrana (1971—1976. godine) nađene su u kanalskom području larve i postlarve sedam vrsta mezo i batipelagičnih kao i jedne bentopelagične vrste riba. Kako se ove vrste pojavljuju u kanalskom području samo u hladnijem periodu godine (oktobar — mart), mogu se smatrati dobrim indikatorima strujanja površinskih vodenih masa od otvorenog mora ka obali jer se sezona reprodukcije na otvorenom moru gotovo kod svih nađenih vrsta proteže na čitavu godinu.

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